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Value Engineering Study of Mowing Operations

U.S. Department of Transportation
Federal Highway Administration

Combined State Studies of Selected Maintenance Activities. A Cooperative Analysis by Teams from Alabama, Florida and Georgia.

March 1982

FCP Category 7

Report No. FHWA-TS-82-209

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FOREWORD

This Tech Share report summarizes the results of a cooperative Value Engineering Study of Mowing Operations. The Study was conducted by the States of Alabama, Florida, and Georgia. The report should be of interest to State and local maintenance engineers concerned with roadside vegetation control.

Research for improving maintenance operations is included in the Federally Coordinated Program of Highway Research and Development in Project 7C, "Improved Technology for Highway Maintenance."

Additional copies of the report can be obtained from the National Technical Information Service, Springfield, Virginia 22161.

R J Betsold

R. J. Betsold
Director, Office of Development
Federal Highway Administration

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16. Abstract

This report is the 11th in a series on Optimizing Maintenance activities. These studies using Value Engineering techniques are conducted by teams of maintenance and operations engineers from several State highway agencies.

This study was conducted by Alabama, Florida and Georgia. The report includes recommendations in the areas of types of equipment, use of herbicides and enforcement of standards. A combination mowing and herbicide program can result in a substantial reduction in the cost of mowing activities.

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RECOMMENDATIONS

1. Eliminate flagman/truck driver from mowing crew. Provide high intensity strobe light and flags on tractors in lieu of warning signs.
2. In most areas, the optimum equipment combination will be two 15' mowers and one 6' mower. Seventy horsepower tractors are needed for the 15' mowers while 50 - 55 horsepower tractors should be used with a 6' mower.
3. Acquire high production broadcast equipment to apply herbicides for controlling tall grass and broadleaf weeds.
4. Enforce a 6" mowing height statewide. Even though standards require this height, often times in actual practice mowing height is less than 6". Mowing at the 6" standard results in safer mowing, lessen the horsepower requirements, and increase grass vigor.
5. Carry in crew truck, fuel, motor oil, water for radiators and tools for minor repairs. In one state a fuel truck or mechanics truck are required for even minor servicing.

STUDY APPROACH AND BACKGROUND

This project was initiated in March 1980, by Task Order Agreements with the states of Alabama, Florida, and Georgia to review the mowing operations of each state, and "using a team approach, study everything about this activity to identify changes that could be made to improve it".

Following the selection of the study team, meetings were held in each state to allow the team to review and discuss their respective mowing operations. A final meeting was held in Tallahassee, Florida, in order to finalize the team's recommendations.

After reviewing the mowing operations and the associated statewide data; such as acres mowed, man-hours per acre, and cost per acre, it was decided that for comparision purposes, similar districts from each state would be selected in order to eliminate the special considerations affecting the mountainous areas of northern Alabama and Georgia. It was agreed that the southern parts of Alabama and Georgia, and northern Florida are similar in the types of terrain, vegetation, and climate and should be directly comparable.

In addition, it was decided that due to the fact that approximately 80 percent of the mowing expenditures for each state occur in the rural areas, only these operations would be compared. This is in agreement with established Value Engineering techniques where the "high cost items" are reviewed first.

DISCUSSION

Each state has prepared guidelines for roadside mowing that specify the limits that are to be routinely maintained. These were prepared to assist in establishing uniformity of mowing operations and to provide a more economical utilization of personnel and equipment. Implementation and enforcement of these guidelines has resulted in a reduction of the total acres mowed and provided an improved service level to the areas to be maintained.

During the first meeting of the project team, each state presented their respective guidelines and standards for mowing operations. These were compared and found to be very similar relative to the areas designated for routine mowing, mowing height, types of equipment used for rotary mowing, and frequencies of mowing (chemical mowing included).

The figures on the following pages generally illustrate the mowing limits in rural areas for all three states. The areas no longer designated for routine mowing are regenerating to a stand of natural and native roadside vegetation of trees, shrubs, and grasses.

The mowing height for each state has been established as approximately 6 inches. Raising the cutting height to 6 inches has provided numerous benefits. It has reduced scalping of the turf caused by over zealous operators as well as provided for a higher quality turf. Other benefits include a reduction in the

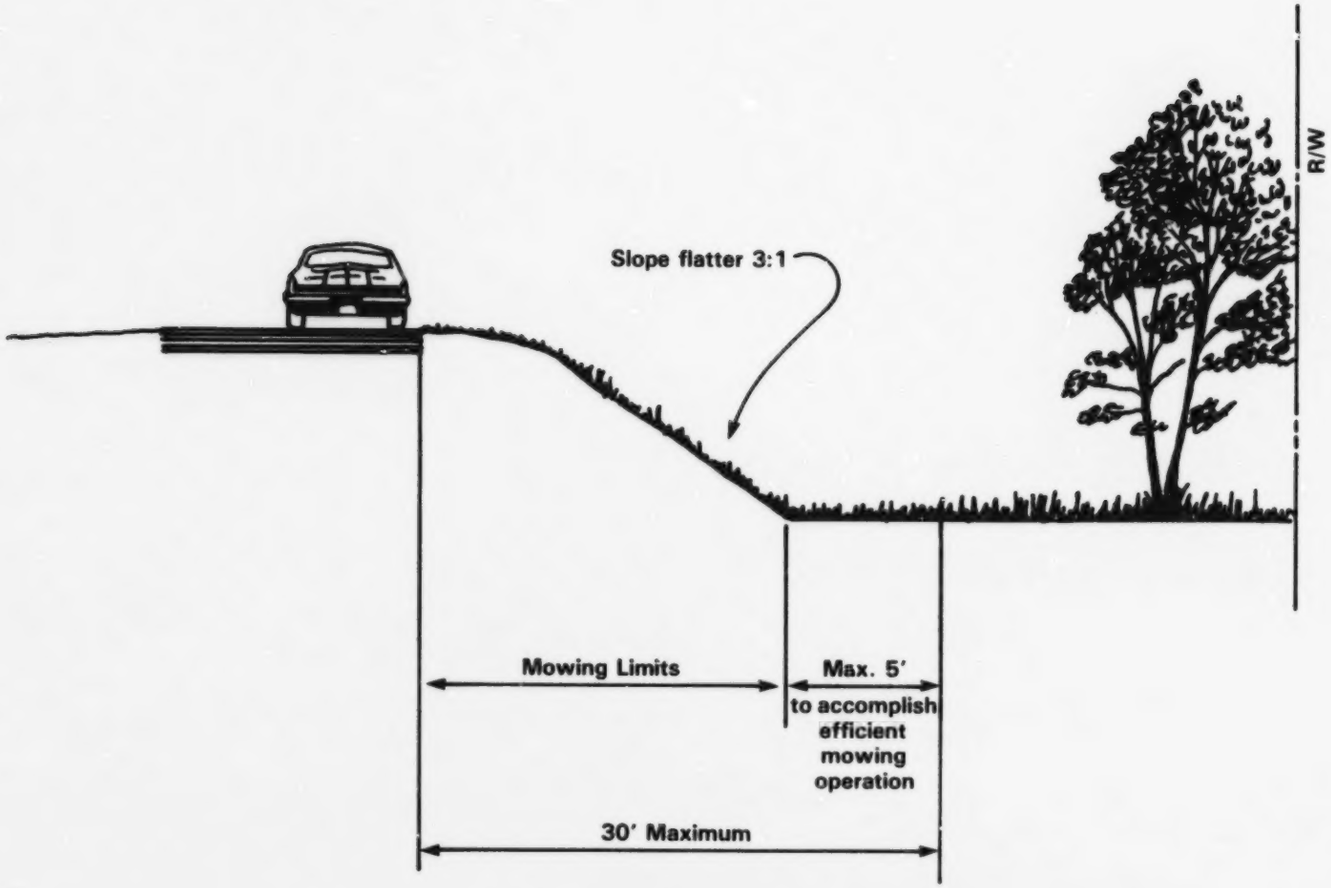

Figure 1 Mowing Plan for Rural Section

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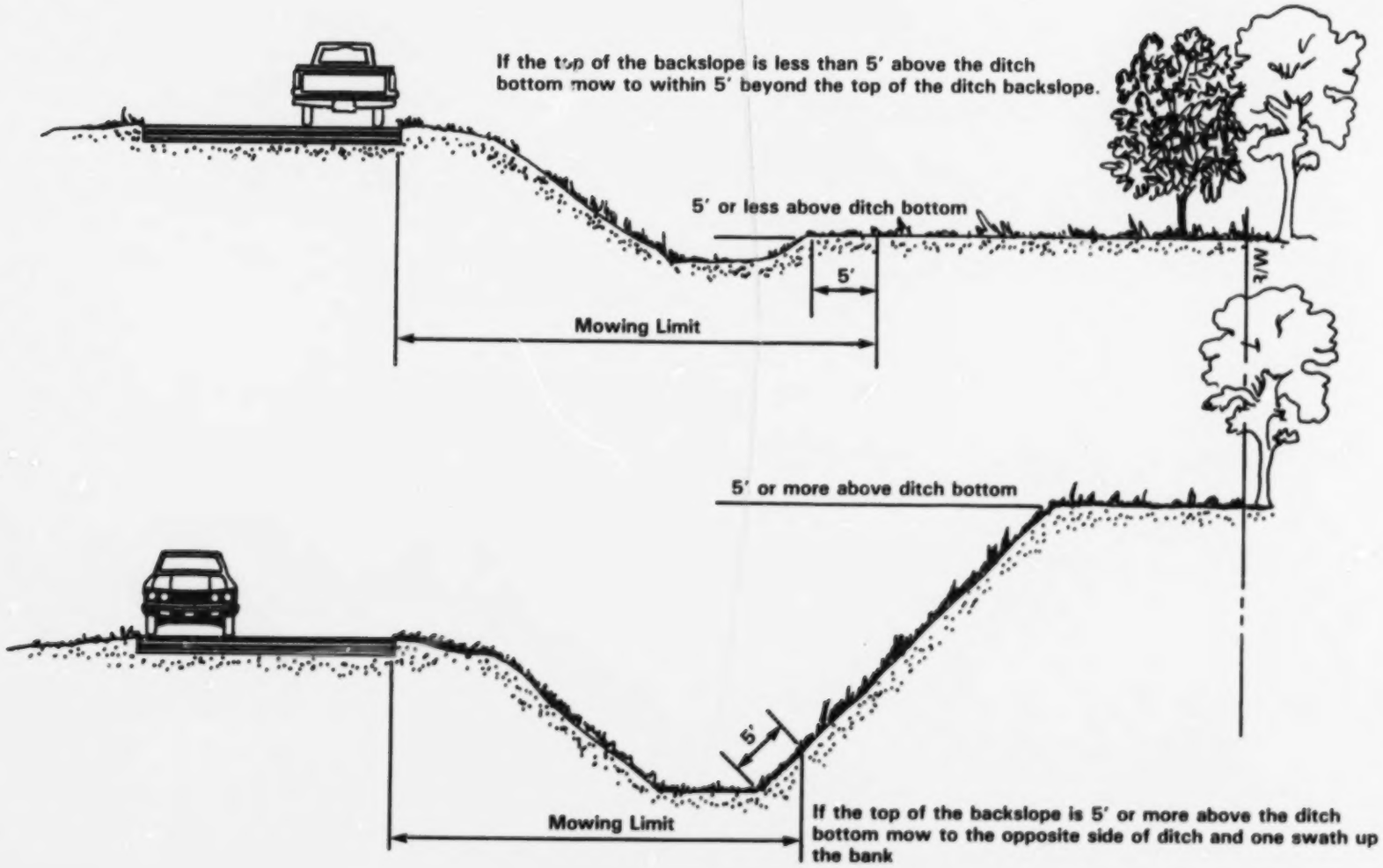
If the top of the backslope is less than 5' above the ditch bottom mow to within 5' beyond the top of the ditch backslope.
5' or less above ditch bottom
5'
Mowing Limit
R/W
5' or more above ditch bottom
5'
Mowing Limit
If the top of the backslope is 5' or more above the ditch bottom mow to the opposite side of ditch and one swath up the bank

Figure 2 Mowing Plan for Rural Section

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★ Mowing To The Edge Of Woods Or Planted Areas Should Be To A Point As To Not Damage Equipment Or Vegetation.

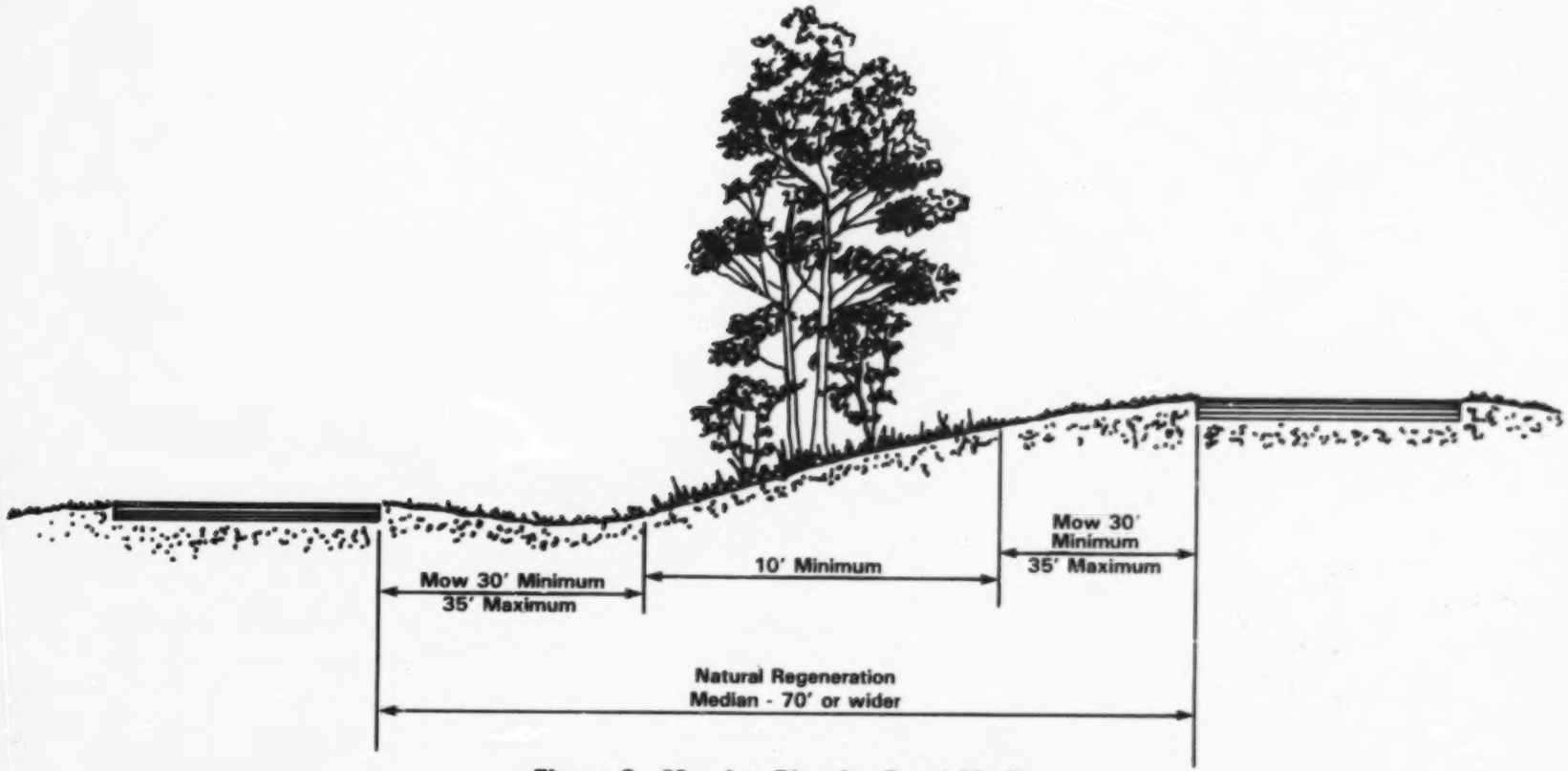

Figure 3 Mowing Plan for Rural Median

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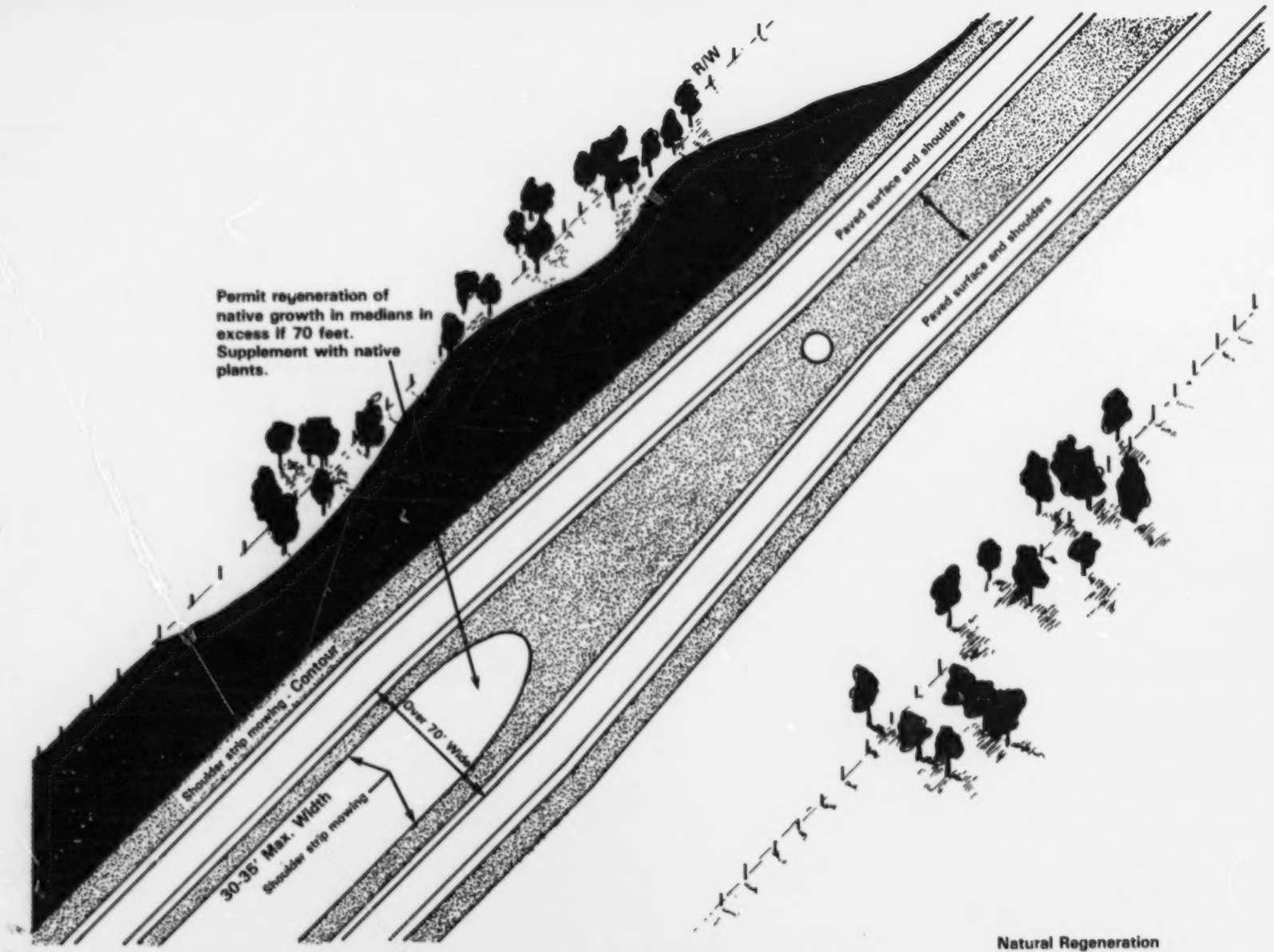
R/W
Permit regeneration of native growth in medians in excess if 70 feet. Supplement with native plants.
Paved surface and shoulders
Paved surface and shoulders
Shoulder strip mowing - Contour
Over 70' Width
30-35' Max. Width
Shoulder strip mowing
Natural Regeneration
Median - 70' or wider

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Figure 4 Mowing Plan for Rural Median

number of accidents and claims caused from projectiles being thrown from beneath the mowers, a reduction in the amount of paper and other unsightly litter being scattered along the slopes, and less wear and tear on the tractors and mowers.

Enforcement of the guidelines for mowing limits and cutting height on a statewide basis has been a problem for each Maintenance Division. Old habits such as mowing from Right-of-Way line to Right-of-Way line and close cutting for appearance have proven to be tough to change. Additionally, the encroachment of woody plant species in the areas not routinely mowed has caused some concern. State forces and utility companies are affected with this regeneration and periodically must cut and/or trim trees and brush in selected areas.

The types of equipment utilized for rotary mowing by each state was also considered to be very similar in respect to size, effectiveness, and equipment life. Conclusions pertaining to the most effective combinations of mowers and tractors are discussed in the Economic Considerations chapter of this report.

Major differences were found in each state's chemical mowing programs and are described later in this report. Chemical mowing is considered to be an area where significant savings can be realized in the states of Alabama and Florida. In Alabama and Georgia, chemical mowing through the use of herbicides has reduced the rotary mowing frequencies from four times annually to twice per year. Florida continues to mow an average of five times each year.

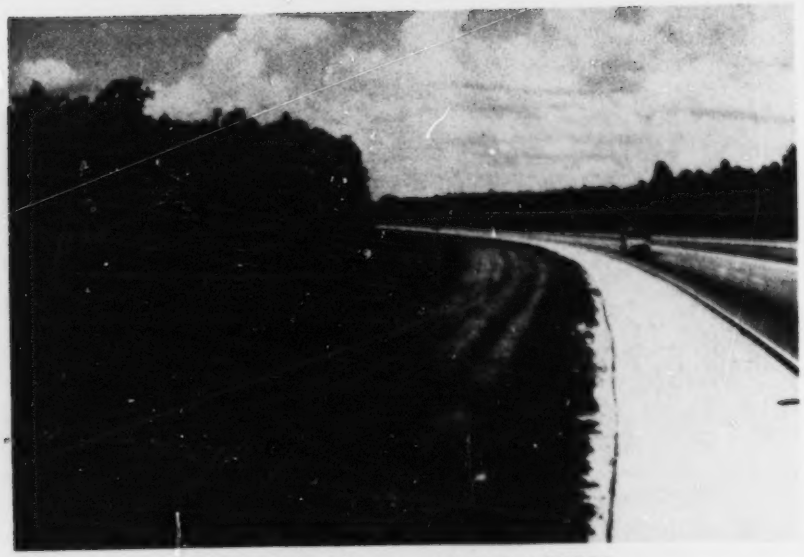

Figure 5 PROPER MOWING LIMITS

Figure 6 SCALPING OF TURF CAUSING DAMAGE TO SOD AND TO EQUIPMENT

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Figure 7 PROPER MOWING HEIGHT(6 INCHES)

Following is a description of each state's personnel and equipment requirements for rotary and chemical mowing crews in rural areas.

Rotary Mowing

In Alabama a typical rural mowing operation would consist of the following:

5-men

3-15' mowers

1-6' mower

4-50 H.P. tractors

1-1 1/2 ton flat truck

The truck driver is used to set up safety signs and provide any hand work that may be needed with the mowing operation. The truck carries extra fuel, tools, blades and in some cases an air compressor for use in fixing flat tires.

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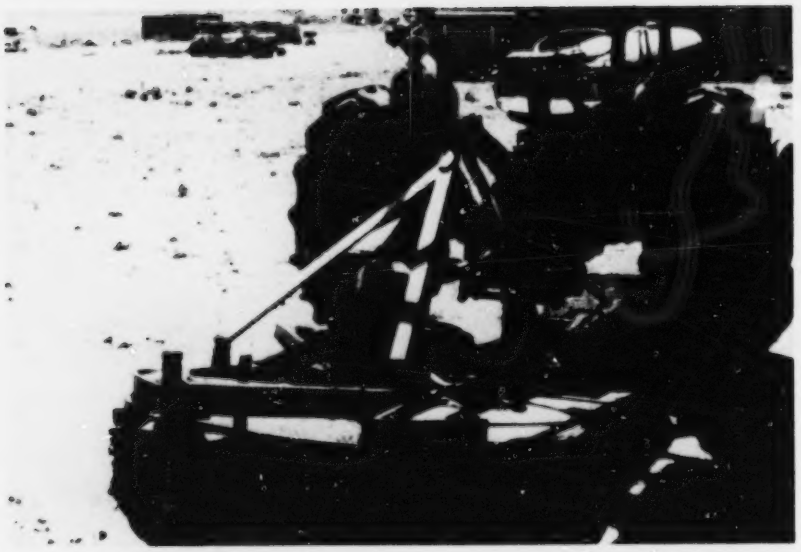

Figure 8 ALABAMA 50 H.P. TRACTOR AND 6' MOWER

Figure 9 ALABAMA 50 H.P. TRACTOR WITH 15' "BATWING" MOWER

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In Florida, a typical rural mowing operation would consist of the following:

3-men

1-6' mower

2-15' mowers

3-55 H.P. tractors

1-1/2 ton pickup

The truck is used to transport the mowing crew to the work site, then towed behind one of the mowers by the use of a hitch mounted on the front of the pickup, to a location central to the work site. At this point, the truck is unhitched from the mower and usually only moved when the work area changes or to carry the crew back to the yard.

Florida has determined that due to the fact that roadside mowing is a moving operation, it is not necessary to place safety signs along the roadway. The pickup also transports fuel, servicing equipment, parts, tools and other items essential to the operation as well as towing the smaller mowers to and from the shop for repairs. Routine servicing and minor repairs are performed on equipment in the field by the operators, e.g. tire repair, blade replacement, belts, bearings and etc.

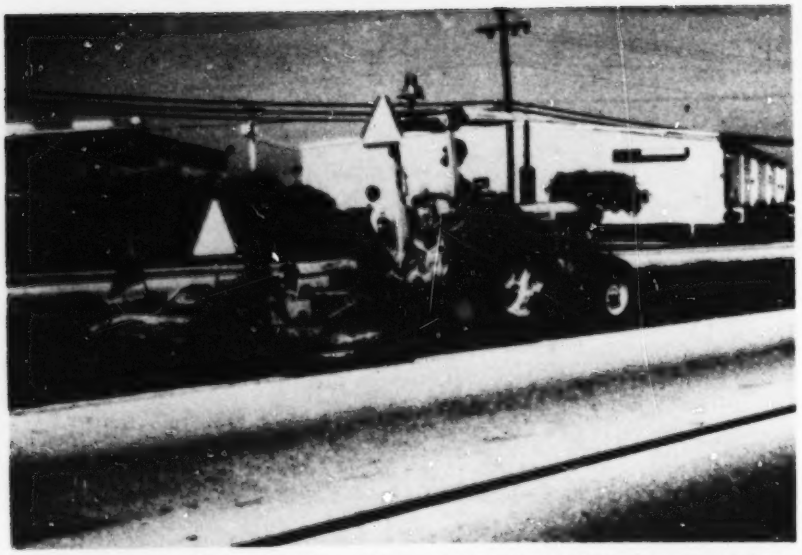

Figure 10 FLORIDA 6' MOWER - NOTE SAFETY SIGNS AND STROBE LIGHT

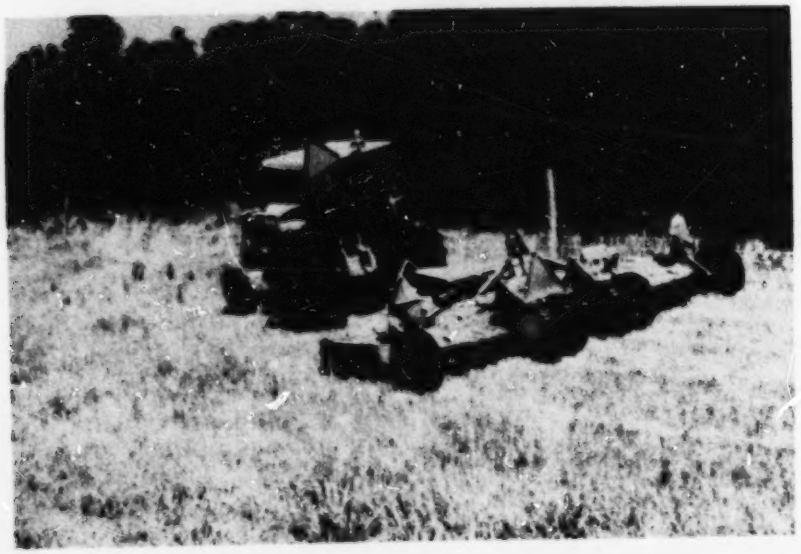

Figure 11 FLORIDA 15' "BATWING" MOWER

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Figure 12 TOW BAR ON PICKUP FOR MOVING WITHIN WORK AREA

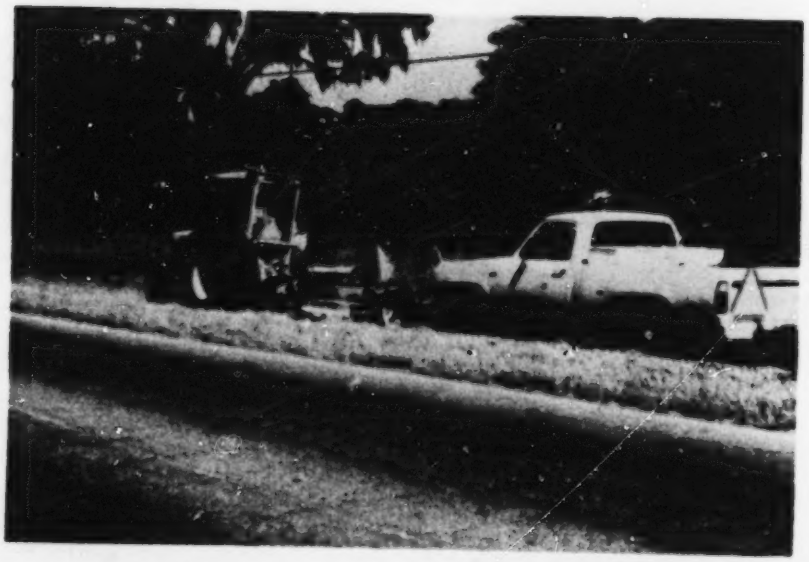

Figure 13 MOVING PICKUP TO CENTRAL LOCATION

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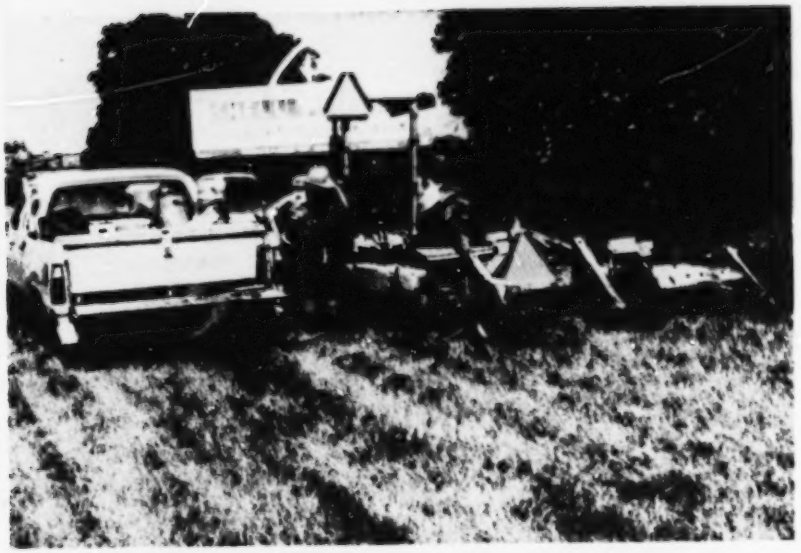

FIGURE 14 TRACTOR OPERATOR PERFORMING FIELD REPAIRS

Typically, a Georgia mowing operation would consist of the following personnel and equipment.

5-men

3-6' mowers

1-15' mower

4-55 H.P. tractors

1-1 1/2 ton pickup

As in Alabama the truck driver is used principally to move the safety signs along with the movement of the mowers. Productivity and cost associated with each of the states rotary operations will be analyzed in the Economic Considerations Chapter of this report.

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Figure 15 GEORGIA TRUCK DRIVER MOVING SIGNS WITH MOWING OPERATIONS

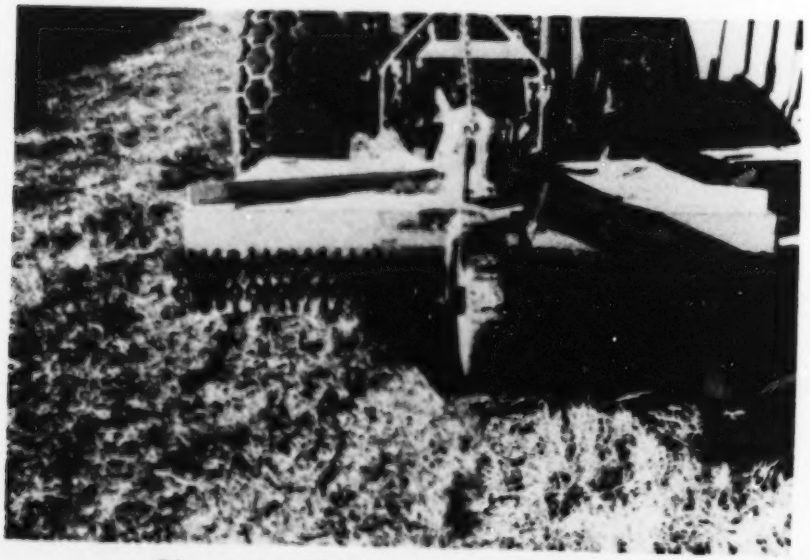

Figure 16 GEORGIA 6' ROTARY MOWER

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CHEMICAL MOWING

The chemical mowing program in Alabama has provided savings to the Department by reducing the annual mowing frequencies from 4 mowings to 2 mowings. This has been accomplished with 2 herbicide sprayings per year at a cost per acre less than that required for rotary mowing. The herbicides used consist of MSMA, and 2,4-D to control tall unsightly weeds and grasses.

Alabama's chemical mowing equipment consists of a low volume tractor mounted sprayer that blows the herbicides on the grass and weeds through the use of 2 boom-mounted fans/sprayers. The herbicide is pumped from a 100-gallon tractor-mounted tank to a hydraulic, remote controlled, 2-fan boom capable of spraying a swath from 3 to 20 feet wide. A typical Alabama chemical mowing crew would consist of the following:

4-men

2-50 H.P. tractors and sprayers

1-1 1/2 ton flat truck

1-water truck

As with the rotary mowing crew, one truck driver keeps up the safety signs and flags in the work area while another driver hauls water to the sprayers.

Figure 17 ALABAMA CHEMICAL "SPAN SPRAYER"

Figure 18 CLOSE UP "SPAN SPRAYER"

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Unlike Alabama and Georgia, Florida does not currently have a "chemical mowing program". This is due to the unavailability of herbicide(s) that will perform selectively to remove undesired grasses without serious damage to the desired Bahia and Bermuda turf. A selective broadleaf weed control program is conducted utilizing 2.4-D individually and in combination with Dicamba.

Although MSMA as used by Alabama and Georgia will perform selectively in Bermuda turf, it is damaging to Bahia grass and not considered acceptable in Florida's program. Additionally, MSMA, an organic arsenical, is classified as a persistent pesticide and requires special considerations for broadcast use.

Florida is reviewing several experimental herbicides that may prove beneficial in achieving a selective broadcast or "chemical mowing program" for controlling undesired grasses and broadleaf weeds.

Additionally, Florida is experimenting with yet another concept of roadside vegetation management. It is the use of a uniquely constructed herbicide applicator that allows for the treatment and control of tall-competitive and undesired vegetation. The applicator applies a herbicide solution, through gravitational flow, to the vegetation by wiping with an absorbent material (rope wick) that is saturated with the herbicide. The herbicide, Glyphosate, is absorbed and translocated throughout the plant and results in control of a target weed, above and below the ground.

The unit is mounted on the front of a tractor where the operator hydraulically controls the height and wing angle. The ropes are constructed on an angle to provide maximum rope-to-weed contact. Diamond braid-nylon over acrylic ropes have provided the best results.

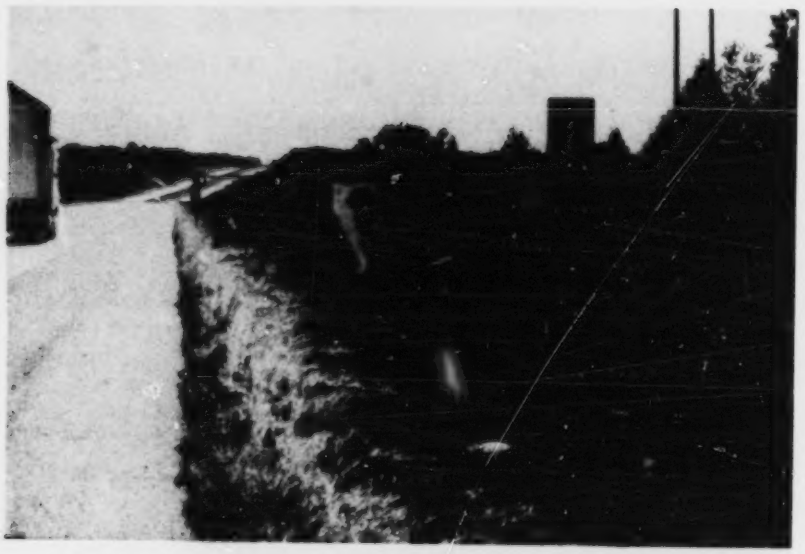

FIGURE 19 TALL UNSIGHTLY GRASSES AND WEEDS

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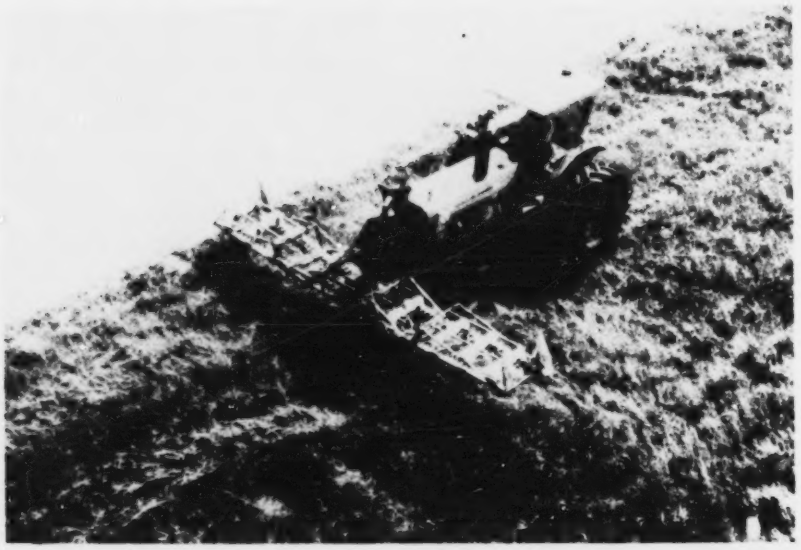

Figure 20 FLORIDA CHEMICAL "ROPE-WICK" APPLICATOR

Figure 21 CLOSE UP VIEW OF "ROPE-WICK" APPLICATOR

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Georgia has also reduced its rotary mowing frequency from four annual mowings to two through the use of a strong chemical mowing program. The herbicide MSMA, is used to control the tall, unsightly weeds, as well as retarding the growth of the Bahia, with a normal two-sprayings per year. Georgia's chemical spraying equipment consists of a truck mounted 1257 gallon tank with spray booms on each side of the truck. A 1/2-ton pickup with directional arrow board follows the spray truck for traffic control.

The booms may be up to 45 feet long with spray tips located on 5-foot centers. These booms can be raised to an angle of 45^{o} through the use of hydraulic cylinders to provide clearance of most obstructions. All controls for operating the spray unit are located on the dash of the truck and are operated by the truck driver. The truck is operated at 18 mph when spraying, with a working pressure of 30 psi. The personnel and equipment required for a chemical mowing crew consists of the following:

3-men

1-3 ton spray truck

1-1/2 ton truck, traffic control

1-water truck

Figure 22 GEORGIA CHEMICAL SPRAY TRUCK

Figure 23 GEORGIA CHEMICAL SPRAY TRUCK OPERATING IN MEDIAN AREA

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ECONOMIC CONSIDERATIONS

As stated earlier in this report, the purpose of this V.E. study was to identify areas where roadside mowing cost could be reduced. While mowing is a relatively basic and simple task, the three states combined spent nearly $14,000,000 to mow and spray 1,200,000 acres in fiscal year 79-80. The basic function of mowing was reviewed and considered to be essential to provide for safety, promote drainage, control erosion, and finally for asthetic reasons. For comparision purposes, costs were developed from districts in each state that were deemed to be similar in the types of growth and terrain. Table I provides a summary of the cost per acre, manhours per acre, personnel and equipment requirements for rural limited access and rural two-lane rotary mowing operations in each state. Table II provides a similar summary for the chemical mowing programs in Alabama and Georgia.

Due to differences in charging equipment time, overhead rates, and minor differences in salary, exact comparisons are not appropriate; however, general conclusions can be drawn. Also, it is recognized that our recommendations may not be applicable on a statewide basis as mowing requirements and conditions vary from one area to another in each state.

Florida's lower cost per acre of $6.08 for Interstate mowing, when compared to Alabama ($9.91) and Georgia ($9.06), is attributed to two factors. The first is the elimination of one man from each crew that serves as a flagman. As described

TABLE I
Rotary Mowing

	INTERSTATE	2-LANE
COST/ACRE		
Alabama	$9.91	$11.21
Florida	6.08	5.46
Georgia	9.06	8.43
MAN-HOURS/ACRE		
Alabama	0.89	1.05
Florida	0.44	0.43
Georgia	0.85	0.86
FREQUENCY		
Alabama	2	2
Florida	4	4
Georgia	2	2

Equipment and Personnel

ALABAMA	FLORIDA	GEORGIA
5-men	3-men	5-men
3-15' mowers	2-15' mowers	1-15' mower
1-6' mower	1-6' mower	3-6' mower
1-1 1/2 ton truck	1-1/2 ton truck	1-1/2 ton truck
4-50 H.P. tractors	3-55 H.P. tractors	4-55 H.P. tractors

TABLE II
Chemical Mowing

	INTERSTATE	2-LANE
COST/ACRE		
Alabama	$10.84	$8.17
Florida	---	---
Georgia	5.39	5.39
MAN-HOURS/ACRE		
Alabama	0.50	0.37
Florida	---	---
Georgia	0.20	0.20
FREQUENCY		
Alabama	2	2
Florida	---	---
Georgia	2	2

Equipment and Personnel

ALABAMA

4-men
1-1 1/2 ton truck
1-water truck
2-tractors/span sprayers

GEORGIA

3-men
1-spray truck
1-water truck
1-pickup

earlier in this report, Florida has classified mowing as a moving operation which allows highway signing to be eliminated in accordance with the Manual on Uniform Traffic Control Devices. Also, by utilizing Florida's towing concept for the crew truck, the truck is always available in the work area. Currently, in Alabama mowing crews have one member whose duties consist of operating the truck, moving the highway signs, hand-trimming, and coordinating the operation at a man-hour rate of $6.34/hour for a 10-hour day. Thus, an average per-day savings of $63.40 extended over their 4-day week for the 5 1/2-month mowing season would total $5,579.20 per year for each crew. This change alone would reduce the Alabama cost per acre from $9.91 to $8.62 and also decrease the manhours per acre from .86 to .68. Georgia has estimated that this change would provide an annual savings of approximately $150,000 in their southern districts alone.

The second factor contributing to Florida's lower cost per acre was attributed to a more efficient equipment combination. In reviewing the mowing limits for rural roadways, each state has established a width of 30 to 35 feet from the edge of pavement as the area to be mowed. On Interstate roadways where the grades, shoulder slopes, and ditches provide for a more ideal mowing area, two 15-foot mowers and one 6-foot mower for cleanup should provide the needed cutting width with one pass. Applying Florida's statewide average productivity rate for 15-foot mowers of .332 man-hours/acre .714 man-hours/acre for a 6-foot mower, a

theoretical Interstate mowing crew in Georgia would provide the following analogy.

Daily Cost

3 men @ $6.75/hour x 8 hours =	$162.00
(2) 15-foot mower @ $6.75/hour x 8 hours =	108.00
(1) 6-foot mower @ $3.75/hour x 8 hours =	30.00
(1) crew truck @ $1.50/hour x 8 hours =	12.00
Total daily cost	$312.00

Daily Production

(2) 15-foot mowers @ .332 Mh/Ac x 8 hours =	48.19 Ac
(1) 6-foot mower @ .714 Mh/Ac x 8 hours =	11.20 Ac
Total Production	59.39 Ac/Day

Cost Per Acre

$312/59.39 Ac = $5.25 Ac

Man-hours Per Acre

$24 Hr/59.35 Ac = .404

Theoretically, this equipment combination, along with the elimination of the flagman, would decrease Georgia's cost per acre for Interstate mowing from $9.06 to $5.25 and increase productivity from 0.85 man-hours per acre to 0.40 man-hours per acre. An observation of the study team is that with the combination of rotary mowing and chemical mowing to control the tall weeds and grasses only, a heavier growth of grass is encountered during the rotary mowing cycles requiring the operators to mow at lower speeds than Florida is experiencing with the four rotary mowings per year.

In the area of chemical mowing, new, high-production, broadcast spraying equipment offers the potential for savings to Alabama and Florida when compared to current practices. Spray nozzles located on the frontof a truck are capable of broadcasting the herbicides to cover a swath up to 36' wide while traveling at speeds up to 10 mph. This equipment has been designed specifically to meet the need of roadside vegetation management. Alabama has projected the cost per acre of utilizing this equipment and compared it to their cost per acre for span spraying.

Span Spray vs. High Volume

Cost Per Acre

	MSMA $1.45/pt	Nalcotrol $0.30/oz	Total Chemical	Labor	Equip.	Total
SPAN SPRAY	3 pts. 4.35	1.6 oz $0.45	$4.80	60 Ac/day $3.38	$3.13	$11.31
HIGH VOLUME	4 pts. 5.80	2.0 oz $0.60	$6.40	120 Ac/day 0.64	$1.25	$ 8.29

This projection shows a cost reduction of $3.02 per acre. At the current level of spraying, 106,000 acres a potential savings of $320,120/yr could be realized by the Alabama Highway Department with this high production equipment.

Florida is proposing an integrated mowing system combining high production spraying, ropewick, and rotary mowing. The high production units will be capable of spraying 150 acres per day at an estimated cost of $1.70 per acre with the rope wick units operating at an estimated cost of $4.95 per acre, not including herbicides. Herbicides capable of removing tall competitive,

grassy, and broadleaf weeds would be utilized; e.g., 2.4-D, Divron, Glyphosate, and Hexazinone. This concept involves a rotational broadcast pre- and post- emergence spraying, rope wicking, and mowing of approximately 75 percent of the rural maintained acreage. It is expected that the remaining 25 percent will continue to require routine mowing due to special considerations. Equipment will be acquired to allow for chemical treatment of 1/3 of this acreage each year.

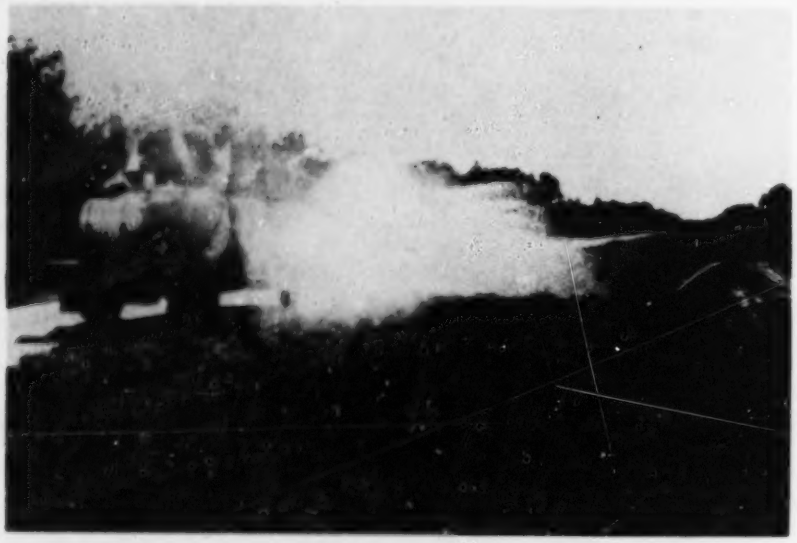

FIGURE 24 HIGH PRODUCTION SPRAYING EQUIPMENT

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Assuming a statewide average of 5 rotary mowings per year, with the cost increasing at a rate of 10 percent each year, the following annual cost per acre comparison is provided for the initial "startup cycle".

Total Annual Cost Comparison for a Given Acre*

	Combined Program		Rotary Mowing Only	
Year 1	2 mow, 2 spray, 1 ropewick	64.50	5 mow	56.95
Year 2	2 mow, 2 ropewick appl.	44.00	5 mow	62.65
Year 3	2 mow, 1 ropewick	38.00	5 mow	68.90
Year 4	2 mow, 1 spray	50.55	5 mow	78.80

* Includes both direct and indirect overhead

It is estimated that a reduction of expenditures of $2.9 million can be experienced over the four-year period with the implementation of the integrated program.

*U.S. Government Printing Office : 1982 -361-428/2124